

## DRAWINGS ATTACHED

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(72) Inventors FELIX IOKHANNESOVICH ELSTROK,  
 KHANS ALEXANDROVICH TOOMEL,  
 KARL KARLOVICH TYUGIYAS  
 and MART PAULIOKHANNESOVICH VIKHALEM

## (54) DEVICE FOR CRUSHING HARD MATERIALS

(71) We, PROEKTNY INSTITUT ESTONSKOGO RESPUBLIKANSKOGO SOVETA MEZH-KOLKHOZNYKH STROITEL'NYKH ORGANIZATSY, of Tartuskoe shosse 16, Tallin, Union of Soviet Socialist Republics, a Corporation organised and existing under the laws of the Union of Soviet Socialist Republics, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a device for grinding solid materials.

Widely known in the art are devices for grinding solid materials comprising two discs carrying grinding elements, the discs being installed on the opposing ends of counter-rotating shafts, and facing each other. The grinding elements may be made in the form of pins or vanes arranged in concentric rows.

The discs are arranged relative to each other such that the concentric rows of the pins or vanes on one disc are located between their counterparts on the other disc. Feed material is charged into the middle of a chamber formed by the discs and, when the discs start rotating, the feed material is struck at a high rate and from opposite directions by the pins or vanes.

The number of impacts is approximately equal to the number of concentric rows of the pins or vanes. Ground particles of the charged material acted upon by centrifugal forces move from the centre of the discs to their periphery and are discharged.

The main disadvantage of this device is an insufficient quality of crushing owing to a limited number of collisions between the material particles and the crushing elements. The number of collisions or impacts depends on the number of the concentric rows of the pins or vanes.

The number of the concentric rows of vanes is also limited because an increase in the number of these rows increases sharply air resistance in the grinding chamber. A number of rows exceeding five or six is not practical since power is spent only for overcoming air resistance in the crushing chamber.

Another disadvantage of the known devices is irregular and rapid wear of the crushing elements especially while handling abrasive materials.

A further known device for crushing hard materials comprises vanes secured in rings mounted coaxially and rotating in opposite directions.

This device has the same disadvantage as the above mentioned device, consisting in irregular wear of the working elements, i.e. the rings to which the vanes are secured.

It is desirable therefore to diminish the disadvantages of the above-mentioned known devices.

Thus the present invention has crushing vanes arranged to increase sharply the number of collisions with the feed material without increasing considerably the air resistance in the crushing chamber.

According to the present invention there is provided a device for grinding solid materials comprising: coaxial counter-rotatable shafts; discs attached to ends of said shafts and facing each other; grinding elements on said discs in the form of vanes each vane extending in length from a centre portion to a periphery of a respective disc; and bafflers one of which extends from an outer end of each vane, the vanes being arranged such that an imaginary line passing through an inner end and an outer end of any vane, in the plane of the disc, forms an angle of more than 90° with the linear velocity vector at a point on the outer end of the said vane.

The device ensures a large number of collisions of the material particles with each vane thus improving the efficiency of crushing and ensuring conditions for the best possible location of a protective layer on the vanes, said layer consisting of the material being crushed and which is constantly renewed owing to the shape of the vanes.

A particular and at present preferred embodiment of the device has curvilinear shape vanes.

For attaining the highest wear resistance it is most practicable that the vane has a logarithmic curve shape, the logarithmic curve being defined as a curve in which one rectangular coordinate of any point on the curve is the logarithm of the other rectangular coordinate.

Also, the vane may be made of a zig-zag shape in length but in all cases it must be deflected in the direction of rotation.

For increasing still further the number of collisions of the ground particles with the vanes and thus improving the efficiency of grinding it is practicable that the front or leading surface of each vane (in the direction of rotation) should be curvilinear.

The same purpose is served by inclining the vanes to the surface of the disc. This requirement becomes most important if the front or leading surface of each vane is rectilinear in cross-section.

For maintaining the optimum speed of air flow from the centre of the grinding chamber, to its periphery, so that the flow allows the ground product to remain in the chamber only as long as necessary, and prevents the backward movement of the ground material under the pressure of the oncoming flow of air, the peripheral end of each vane is provided with a baffle shutting off the space between the vanes.

A particular embodiment of the invention will be described with reference to the accompanying drawings, in which:

Figure 1 is a side elevation of the device for grinding solid material showing a protective layer on the vanes; arrows show the direction of the feed in the grinding chamber;

Figure 2 shows one form of the discs with the vanes bent to a logarithmic curve;

Figure 3 shows the relative positions of vanes on two opposed discs; the arrows show the direction of the feed material;

Figures 4, 5, 6 are partial top views of the discs with vanes of other shapes in length, the vane length being defined as extending from an inner end of the vane to an outer end of the vane; and

Figures 7, 8, 9, 10 and 11 are cross-sectional views of various shapes of the vanes.

With reference to Figure 1 the device comprises two coaxially-mounted shafts 1 and 2 whose confronting ends carry discs

3 and 4 facing each other and carrying grinding or crushing vanes 5.

For obtaining the most uniform and stable protective layer consisting of the ground material, it is most practicable that the vanes should be bent to a logarithmic curve shape and inclined in the direction of rotation as shown in Figures 2, 3.

The pitch of the spiral vane is determined by the consistency of the feed and the internal friction which is largely determined by the feed.

For example, the angle in the disc plane, between the tangent at any point on the vane and the direction of rotation of the point of the vane is approximately  $15^\circ$  for crushing sand. This angle produces a stable protective layer. When each vane 5 has a logarithmic curve shape, the distance between the vanes constantly grows. This increases the distance of free flight of the ground particles thereby increasing the losses of energy of said particles.

In order to reduce the length of the free flight of the ground particles and, consequently, to reduce their losses of kinetic energy in flight, each disc 3 and 4 is provided with additional shorter vanes 6 (Figure 2) installed between the vanes 5. The vanes 6 are curved along the same line as the vanes 5 and have the same pitch.

The front leading surface 11 of the vanes 5 and 6 in the direction of rotation may be of the concave-curvilinear shape as shown in Figure 7. This shape of vanes 5 and 6 ensures the most reliable protection of their edges. To simplify manufacture of the grinding elements of the device it is possible to replace the curvilinear vane by the inclined vanes which each have a rectilinear front, leading surface 11 (see Figure 11).

The peripheral ends of the vanes 5 and 6 are provided with bafflers 7 connected with an adjacent vane which is located in front, in the direction of rotation. The bafflers 7 prevent premature ejection of the ground particles from the grinding chamber formed by the discs 3 and 4. The bafflers also contribute to retaining the protective layer of the vanes 5 and 6, and ensure the optimum speed of the air flow from the centre of the chamber to its periphery thus determining the time during which the material is treated in the crushing zone. Since vanes 5 and 6 are inclined in the direction of rotation and the shafts 1 and 2 with the discs 3 and 4 rotate in the opposite directions, the assembled vanes 5 and 6 of the discs 3 and 4 are set in opposite directions (as shown by continuous and dotted line in Figure 3).

The discs 3 and 4 are installed relative to each other so as to ensure a minimum clearance between the edges of vanes 5 and 6.

Apart from the preferable shape of the vanes 5 and 6 described above, the vanes may be bent on a zig-zag line and inclined in the direction of rotation (Figures 5, 6). Such a shape of the vanes 9 provides for sharper changes in the aerodynamic characteristics of the air flow throughout the grinding zone of the chamber which assists in obtaining the effect of internal separation whereby adequately ground particles leave the inter-disc space and insufficiently ground particles are recirculated through the inter-disc space for additional grinding.

To obtain a maximum crushing effect it is a good practice to make the vanes 10 of a curvilinear shape (Figure 4) with a variable pitch along their length from the middle of the disc to the periphery; at the same time the front surface 11 of the vane 10 in the direction of rotation can be curvilinear in cross-section, the front working surface 11 of the vane 10 being concave at the ends (Figure 7) and convex in the middle (Figure 8), these portions of the front surface smoothly merging into one another.

With such an arrangement, the peripheral ends of the vanes become covered with a protective layer of the ground material while the convex profile of the middle section of the vane contributes to the axial movement of the material particles in the given zone which increases the number of collisions between said particles and the vanes.

To simplify the manufacture of the discs 3 and 4, the front surface 11 of the vane may be either inclined (Figure 11) or have a trapezoidal cross-section (Figure 9).

The peripheral ends of the curvilinear vanes 10 or of zig-zag vanes 9 are also provided with bafflers 7a (Figures 4, 5, 6) which form an angle of less than 90° in the disc plane with the direction of rotation of the free end of the baffle. As in the other forms of the vanes 5 and 6, these bafflers shut off the space between the vanes and maintain the optimum speeds of the airflow in the grinding zone of the chamber formed between the discs 3 and 4.

The device for grinding solid materials functions as follows:

Motors (not shown) coupled with shafts 1, 2 rotate the discs 3 and 4 in the opposite directions. The hard, loose, solid material to be ground is charged into the grinding chamber formed between the discs 3 and 4 (the interdisc space) through the hole 12 (Figures 1, 2) of the disc 3 from a hopper (not shown). This material is set in motion initially by strips 13 (Figures 1, 2, 3) after which it moves over the vanes 5 and 6 of the disc 3, is accelerated and directed to the counter-rotating disc 4, being struck by its vanes 5 and 6 (the movement of the ground particles is shown by arrows in Figures 1, 2, 3).

The blow dealt by the vanes 5 and 6 of the disc 4 throws the particle back into the working zone of the disc 3. Thus, the blows follow each other at a high rate from opposite directions until the hard material becomes completely ground. Small particles of the ground material are carried out of the grinding zone by the flow of air which is directed outwards by means of strips 13 and bafflers 7. Settling on the front working surface 11 of the vanes 5 and 6 (Figure 7), the ground particles form a protective layer 14, thus preventing wear of the vanes.

During the rotation of the discs 3 and 4, the protective layer 14, (Figures 1, 7) formed in the course of grinding on the vanes 5 (Figures 1, 2, 3), acts as a striking element, this is accompanied by simultaneous disintegration of the colliding particles and particles from the protective layer itself.

The ground particles are constantly removed from the surface 11, being replaced by new ones. The protective layer 14 is formed only at a certain inclination of the vanes, this inclination depending on the properties of the material being crushed.

The operation of the device with vanes of other shapes is similar to that described above, the sole difference consisting in the nature of formation of the protective layer which has already been described above.

#### WHAT WE CLAIM IS:—

1. A device for grinding solid materials comprising: coaxial counter-rotatable shafts; discs attached to ends of said shafts and facing each other; grinding elements on said discs in the form of vanes, each vane extending in length from a centre portion to a periphery of a respective disc; and bafflers one of which extends from an outer end of each vane, the vanes being arranged such that an imaginary line passing through an inner end and an outer end of any vane, in the plane of the disc, forms an angle of more than 90° with the linear velocity vector at a point on the outer end of said vane.

2. A device according to Claim 1, wherein each of said vanes is curvilinear in length.

3. A device according to Claim 2, wherein each of said vanes has a logarithmic curve shape in length.

4. A device according to Claim 1, wherein each of said vanes extends in a zig-zag line along its length.

5. A device according to Claim 1, wherein a front leading surface in the direction of rotation of each of said vanes is curvilinear.

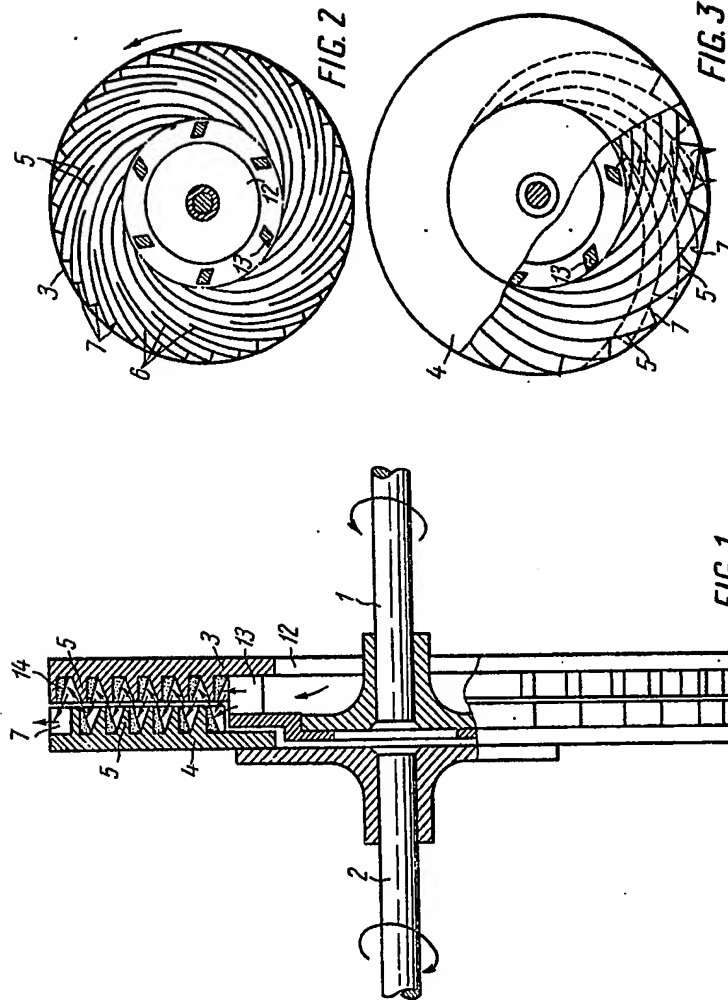
6. A device according to Claim 1, wherein each of said vanes is inclined to a surface of the discs.

7. A device according to Claim 1, where-

in each baffle shuts off a space between described with reference to and as shown in 5  
the vane from which it extends and an adjacent vane. the accompanying drawings.

8. A device substantially as hereinbefore MARKS & CLERK.

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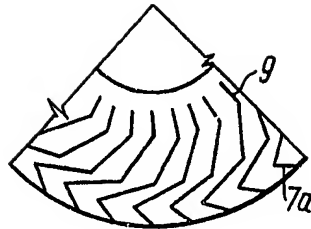


FIG. 5

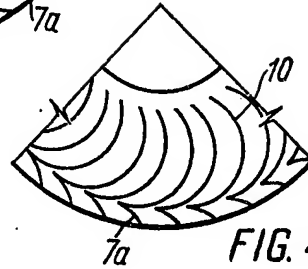


FIG. 4

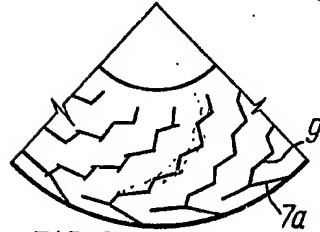


FIG. 6

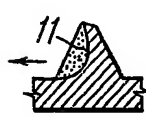


FIG. 7



FIG. 8



FIG. 9

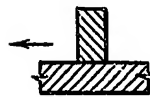


FIG. 10

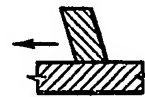


FIG. 11